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TRANSLATION OF TWO SOVIET PAPERS ON BLACK SEA DOLPHINS

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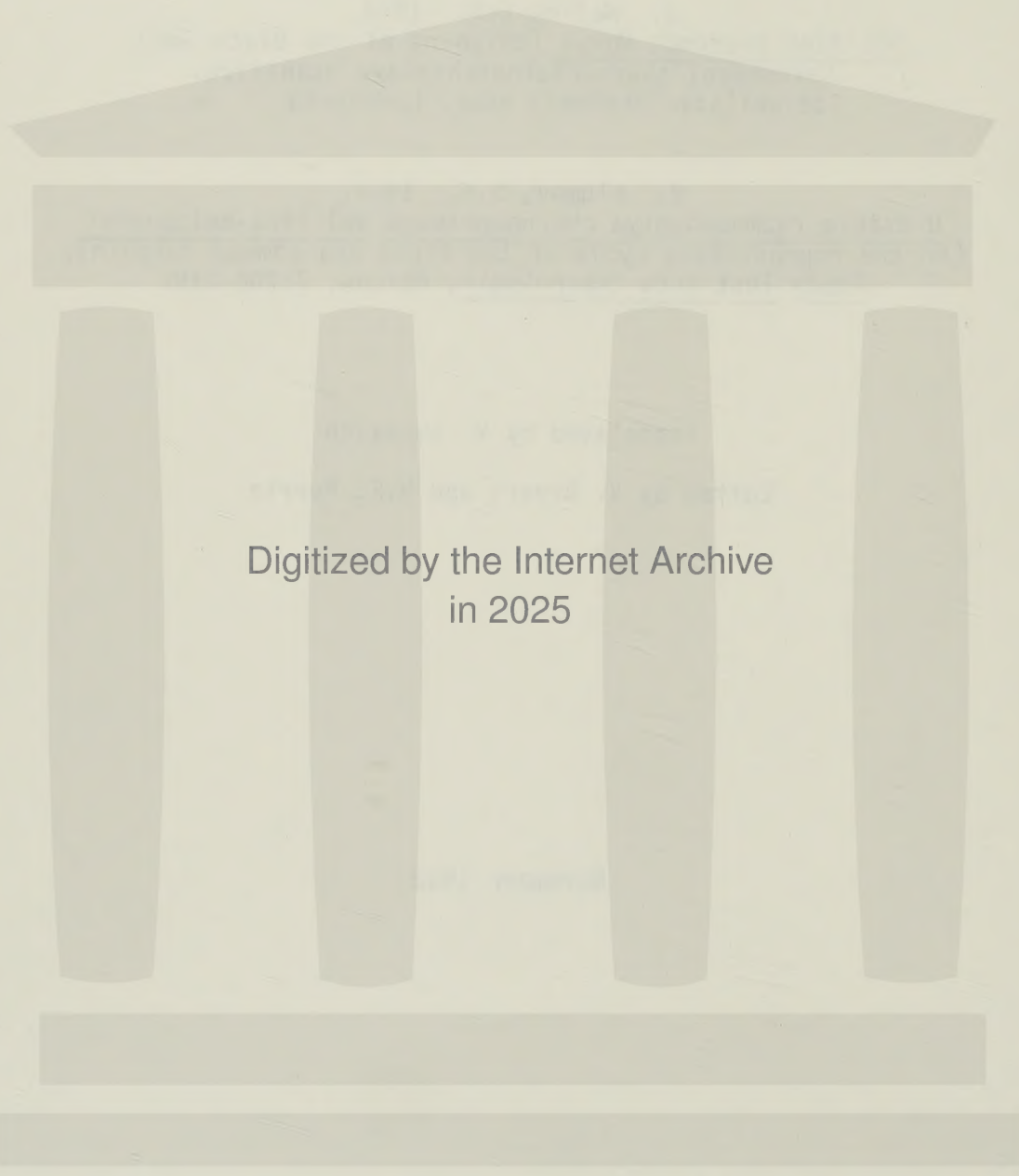
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Academy of Sciences of U.S.S.R.
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E.N. Mal'm

DOLPHINS OF THE BLACK SEA

Publishing House of Academy of Science
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1932

THE SPECIES OF BLACK SEA DOLPHINS

Everyone who has cruised the Black Sea has undoubtedly encountered fast-swimming, leaping, and breaching animals, displaying wonderful play behavior. These animals are dolphins. The dolphin is a marine animal, similar to the seal, walrus and other marine mammals, and belongs to the group of so-called toothed whales.

The ancestry of the dolphin, like that of all cetaceans, dates from a very early geological period. Dolphin evolution is an extremely interesting example of adaptation in the animal kingdom, for it demonstrates the change from a terrestrial to an aquatic environment. The reasons for this interesting transition were probably an increase in competition for food and an increase in interspecific competition.

As a result of a changing habitat and lifestyle, dolphins and other Cetacea developed unique adaptations to the aquatic environment. This process took thousands of years. Anything that might increase body surface area, and consequently increase friction during locomotion, gradually degenerated. Hair disappeared completely and the skin became very smooth. The external ear is absent and the external auditory opening became rather small. The anterior extremities developed into pectoral fins; small bones (6-7 cm in length) found in the muscles of the pelvic region are posterior extremities that have completely atrophied. The shape of the body became more fish-like, since this is more effective for swimming. This type of adaptation is a very good illustration of the influence of the surrounding environment on individual metamorphosis and the great plasticity of living organisms undergoing such adaptations. Because of the striking resemblance of the dolphin body to that of the fish, people who are not familiar with the biology and anatomy of these animals often mistakenly called them "fish." But this is far from the truth. The anatomy and physiology of these animals strongly indicate that dolphins are true mammals.

Dolphins have three types of fins: pectoral (2), dorsal (1), and caudal (1). The pectoral fins have a long skeleton that is equivalent to an extremity with five digits (Figure 1). Dorsally (normally called "feather") and horizontally placed caudal fins do not have a skeleton and consist of solid connective tissue. The dolphin's body is covered with thick, elastic fatty layers. A thin layer of epidermis covers the surface of the skin, and it can be easily removed if a dead dolphin has been out of water for two to three days. The underlying epidermis is a very dense, slightly pinkish-

yellowish layer of skin 1.5-2 mm thick. Next is a fatty layer, which fluctuates in dimensions for different species but can reach up to 4-5 cm in thickness. The fatty layer is very important for the dolphin since this is a warm-blooded animal; its constant body temperature is higher than the temperature of the surrounding water. Fat lowers the specific gravity of the animal and facilitates its buoyancy. In addition, due to its low heat conductivity, fat diminishes the loss of energy into the surrounding environment. The average size dolphin (64-72 Kg) carries about 20 kg of body fat during the summer, but in the winter this amount nearly doubles. This phenomenon apparently correlates with the better feeding conditions in the fall and the winter-spring season when small schooling fishes are abundant. Variation in the thickness of the fatty layers probably also corresponds to fluctuation of the water temperature. When the water temperature increases in summer, the dolphin's metabolism also increases and a significant portion of accumulated fat is "burned up" (utilized by the animal). Also, the summer is the peak of reproductive activity among dolphins; at this time they feed very sporadically and as a consequence lose a lot of weight. Due to this phenomenon, dolphins killed in the summer usually sink to the bottom. This never occurs in winter, when they have a higher body content of fat. In summer, in order to avoid waste (sinkage of dolphins) during the commercial season, fishermen have to dive after dolphins. Usually they hire very experienced divers to perform this job.

Fig. 1 Skeleton of male common dolphin (Delphinus delphis)
Length 162 cm.

Fig. 2 Common dolphin (belobochka) (Delphinus delphis).
Length 172 cm.

Three species of dolphins inhabit the Black Sea. They differ anatomically, but also in some other biological peculiarities. The most abundant species of Black Sea dolphins is the common dolphin (Delphinus delphis) or "belobochka." This species has the most attractive color pattern compared to those of the other two species. The dorsal part of the body is black, gradually shading into grey on the lateral and ventral areas. The lateral parts of the dolphin's body have black, grey and white contours. The ventral and lateral parts of the body are predominantly white, from which originated the vernacular name "belobochka."

The main feature in the external appearance of this species, which distinguishes it from other Black Sea dolphins, is the very elongated beak-like facial area with a sharply raised frontal part of the skull. The dorsal fin has a relatively narrow base and is taller than that of other dolphins. The average length of the common dolphin is 150-170 cm. The maximum length, which is rarely seen, is 215 cm. The average weight is 56-70 kg, with a seldom seen maximum of 100 kg. There is no sexual dimorphism in external appearance. Only by thorough investigation can it be noted that in males the peduncle is somewhat thinner than in females.

Fig. 3 Skull of the common dolphin (Delphinus delphis).
Length 36 cm.

The common dolphin has a great number of very small sharp teeth (an average of between 160 and 240) in both jaws. The lower jaw protrudes (0.5-

0.75 cm) beyond the upper jaw. Both jaws have spaces between the teeth so the teeth of the upper jaw fit between teeth of the lower jaw, forming a solid row of teeth. Thus, the oral cavity of the dolphin is completely closed when the jaws are together.

The common dolphin has one color variation that differs from the usual pattern: a sharply outlined, long black stripe that runs from the upper jaw to the pectoral fins. This color variant also has a vernacular name: "black mustache."

Common dolphins are distributed abundantly throughout the Black Sea all year round. In July, they migrate from the Crimean shores far into the open sea, probably because of migration of their food. Since it is the most common species in the Black Sea, it is also the main commercial target. The common dolphin is a very widely distributed species throughout the seas of the world. It also inhabits the Atlantic Ocean.

The smallest species of Black Sea dolphin is called "round face," "azovka," "puffer," or common porpoise (Phocaena relicta Abel). The external appearance of this dolphin is strikingly different from that of the common dolphin. The head is blunt, with no protruding beak.

Fig. 4 Common porpoise ("puffer") (Phocaena relicta Abel).
Length 112 cm.

The dorsal fin in this species is very low, with a wide base. The number of teeth is significantly lower than in the common dolphin (average 80-108 in both jaws). The dorsal part of the body is a brownish-blackish color, showing a gradual transition into white towards the ventral part. The average body length is 100 cm; average weight is 24-32 kg. The common porpoise inhabits predominantly the Azov Sea (all year round). It is also seen in the Black Sea, primarily along the Caucasus shores traveling with small schools of fish.

Along the Crimean coast of the Black Sea (Yalta-Sebastopol regions) the common porpoise arrives in large numbers in October-November, when the Black Sea sprat migrate from the Caucasus waters. The same situation is observed in March-April when the Azov sprat begin to migrate. The common porpoise's fatty layer, compared to those of other species of dolphins, is very soft. Distribution of this species is limited to the Azov and Black Seas; it is never encountered elsewhere.

Fig. 5 Bottlenosed dolphin (afalina) (Tursiops tursio Fabr.).
Length 220 cm.

The largest and rarest of all three Black Sea dolphins species is the "Black Sea pig" or afalina (Tursiops tursio Fabr.). The external appearance of the afalina differs from that of the other two dolphins. The beak is significantly shorter than that of the common dolphin. The teeth are large, with blunt, conical tops, and total from 80-104 in both jaws. Body length reaches 250-300 cm. Average weight is about 100-150 kg; rarely, they reach up to 400 kg. The general coloration is very close to that of the common dolphin, although somewhat darker.

Bottlenose dolphins are very cautious and clever animals, and it is difficult to get close to them. During the daytime they usually sleep in secluded areas along the rocky shore, but in the evening they come out to forage. This species may also be observed in the Marmara and Mediterranean seas as well as in the Atlantic Ocean.

DOLPHIN BIOLOGY

Dolphins, like all other mammals (terrestrial and marine), use lungs as respiratory organs. The lungs are usually large in size and are well-developed. Because of this lung-breathing ability, dolphins must surface periodically to replenish oxygen. Air enters into the lungs through the nasal orifice located in the upper portion of the head, called the blowhole. The blowhole has a muscular elastic valve, which seals the opening when the dolphin submerges. Under natural conditions, when dolphins swim leisurely, the respiratory rate is once every 15-20 sec. During respiration, the blowhole is open for a very short period: first a short expiration occurs, then a brief inhalation occurs. Respiration (expiration and inhalation), as shown by our observations, is very energetic and lasts for a short period of time (one to two seconds).

The thoracic and ventral muscles of the body are involved in the respiratory process, and therefore the dolphin's lungs act as a powerful pump. During respiration, the dolphin's body is drastically deflected, forming a concave arch. The pectoral fins incline somewhat forward and the head and tail move up. Then the dolphin makes 2-3 beats with his caudal fin, opens up the blowhole, and the short respiratory act takes place. Afterwards, the dolphin's body becomes straight again.

Due to the large surface area and well-developed vascular system in the lungs, dolphins may remain under water for up to 30 minutes. This may be necessary when in pursuit of prey or in a situation of danger. The dolphin may cover significant distances under water. This allows it to disappear early during a chase. However, the dolphin may suffocate and drown if it stays under water longer than its lung capacity allows. Dolphins often suffocate after becoming tangled in fishing nets while chasing fish schools. During respiration, dolphins produce very typical sounds that remind one of a swimming horse. In quiet weather, this sound can be heard exceptionally well. Because of this habit, the Black Sea dolphin (Phocaena relicta) that most typically makes this sound has been nicknamed "puffer".

Thus, periodic appearance of the dolphin on the surface is primarily connected with a basic physiological function - exchange of oxygen in the lungs. It is not due to a wish to play, as most people speculate. Dolphins possess good vision and intelligence. Because of this, they immediately dive deep if they detect any guns pointed towards them. Dolphins which have had such experiences become very cautious and disappear immediately if a hunting vessel tries to approach them. Nevertheless, dolphins often follow boats for hours, staying very close to them.

Dolphins apparently have a well-developed auditory apparatus, although the external ear is absent. A definite auditory orifice appears about 3-4 cm behind and somewhat below the eye. Dolphins cannot hear airborne sounds as well as they can hear underwater sounds. This can be explained by increased

conductivity of sound waves in the water as compared to the air. This feature is used by Black Sea fisherman when they create a lot of underwater noise in order to keep dolphins inside the net after chasing- the method is called "telephone" and is always very effective.

The dolphin brain lacks an olfactory organ (bulbus olfactorius). Based on this fact, we may presume that these animals are without a sense of smell.

During the mating process, a male embraces the female with his pectoral fins. Impregnation occurs in the fashion seen in all mammals. During this process, dolphins turn their bodies side-by-side and continue swimming without interruption. A definite breeding season in dolphins cannot be positively determined. This period is rather extended, since we were able to obtain fetuses in different states of prenatal development throughout the year. The most intense reproductive season, based on the author's observations, is from May until September. During this period a great number of males with tooth marks all over their bodies are observed. This is a good indication that males are fighting vigorously for females.

Prenatal development of the dolphin fetus is similar to the fetal development of terrestrial mammals. The gestation period is about 10 months. Females give birth to one, or very rarely, to two calves.

Fig. 6 Fetuses of the common dolphin, from
9 to 32 cm in length.

Figure 6 shows the different stages of prenatal development of dolphins from the first to the third month. Our observations on the biology of the large-toothed whales show that the body length of newborn calves usually equals $1/3$ of the mother's body length. Dolphins are an exception to this rule. Dolphin fetuses, when compared to the mother's length, are rather large. The fetus body size increases drastically in length during the last stages of prenatal development. The fetus size reaches almost half the size of the females body at this time. If the human fetus body ratio were the same as that of the dolphin, a newborn baby would be as large as a 6-year old child.

A fetus of the common dolphin was extracted from a female's body in August 1931. Body length of the pregnant female was 164 cm. Length of the approximately 9-month-old fetus was 72 cm. The umbilical cord can be seen hanging down. The calf is born as a fully developed biological specimen with the mouth full of growing teeth. It is very interesting to note, based on numerous observations conducted by the author, that a newborn calf has embryonic contact with his mother for a significantly longer period of time than that seen in terrestrial mammals. For up to three days (the exact time is not yet established), a calf is connected to his mother by means of the umbilical cord. Some observers indicated that for this period of time the calf swims in close proximity to the mother's body, holding her pectoral fin in his mouth. This extraordinary biological fact, pertaining to this group of mammals, may be explained in the following way: In the majority of mammals, the placenta is expelled very quickly, causing the rupture of a vast area of vascularization. As a consequence, there is considerable bleeding. This bleeding is not dangerous either to the mother or the young because it stops spontaneously due to blood coagulation. In dolphins, as well as in all other

Cetacea, blood does not clot. This phenomenon, called hemophilia, may be observed in humans as well, in some pathological cases. Because of this, dolphins can easily die from bleeding, even from insignificant wounds. Therefore, parturition in dolphins must occur absolutely without bleeding. Hence, the expelling of the placenta takes place gradually, with the healing of the uterus. At the same time, the vascular system in the umbilical cord itself is gradually changed, and when the calf has completely switched to pulmonary respiration, the umbilical cord finally breaks off.

The female has two mammary glands located in the caudal area beside the genital slit. During lactation (nursing), milk squirts out. It is usually white in color and the taste is similar to that of cow's milk. The insignificant amount of milk produced indicates that it is not very important in nutrition of the young; rather, feeding on schools of fish is more important to the young dolphins' diet.

The maternal instinct is well developed in dolphins, especially in the common dolphin. During commercial hunting, when young animals are killed, the mother continues to cruise around the dead body, without attention to the nearby hunters. Hunters usually take advantage of the situation and kill the mother as well.

Dolphins are social animals. They seldom swim alone; more often they can be observed in large congregations called herds. During winter, the number of animals in one such herd may reach tens of thousands and cover several kilometers on the surface of the water. The dolphin's main propelling power is the caudal fin and the tail. The pectoral fins and dorsal fin mainly function to balance and steer the animal. Fast beats of the caudal fin propel the dolphin forward. The beats of the caudal fin are so rapid that there is no way to measure them with the human eye. The pectoral fins are held close to the dolphin's body during locomotion. Dolphins may reach a speed of up to 40 km/hr and can thus leave behind even the fastest moving boat. Very often, dolphins make high jumps out of the water (up to 100 cm). This behavior is typical of all three species of dolphins and indicates the great muscular power of their locomotory organs.

Dolphins sleep on the surface in very calm weather when there is no swell. The blowhole and dorsal fin are usually above the surface. The dolphin's sleep is very easily disturbed, and even an insignificant noise will send it diving into the depths to flee danger.

Antagonistic behavior may be observed between the 3 species of Black Sea dolphins. The common porpoise avoids mingling with the bottlenose dolphin. Likewise, the common dolphin has never been observed in association with the bottlenose. Each species prefers to be independent of the others.

Although dolphins have a rather large body size, their pharynx is relatively small and narrow. Thus, they feed predominantly on small species of fish (sprat, anchovy, herring, mullet, mackerel). The common dolphin prefers sprat. The common porpoise forages mainly on anchovy. The bottlenose dolphin prefers larger species of fish, such as grey mullet. The dolphin is an unbelievably voracious animal and can exterminate large schools of fish. This phenomenon may be observed in spring (March-April) when anchovy are moving from the Azov to the Black Sea. The common porpoise, which inhabits

predominantly the Azov Sea, migrates after schools of anchovy toward Sebastopol bays, devouring them in great quantities. The migration of anchovy schools is so often correlated with the appearance of this species of dolphin that the Black Sea fishermen believe the common porpoise force this commercially valuable fish to the shore and are thus a great help during fishing season. This interesting phenomenon requires additional study. It is likely that dolphins follow the commercial fish as a main source of their nutrition without causing any significant influence on the direction of a natural migratory pattern. Usually the dolphin turns its body to a 90° angle when grasping fish and is sometimes seen turning upside down.

Consumed fish are digested rapidly. I have seldom been able to detect food remnants in a dolphin's stomach, and it is practically impossible to determine the species of fish in stomach contents. Usually I was able to see just chyme or an absolutely empty stomach. In addition, I would like to make a point of the exceptional length of the digestive tract in dolphins. On the average it reaches up to 40 meters, mainly due to the length of the intestine.

Dolphins also prey on shellfish and crustacea. During postmortem study of a common dolphin stomach, I discovered two common crayfish (genus Asiacuo). This also indicates that dolphins travel into the brackish water of the rivers flowing into the Black Sea.

Common dolphins do not adjust very well to captivity because of the need for constant fast swimming. They damage themselves by crashing against the pool's walls. In addition, stranded dolphins rarely survive longer than 24 hours. The latter might be explained by the fact that while in water, the dolphin sustains equal pressure all over its body surface; but while stranded, the pressure of the body weight causes displacement of the internal organs, irregular and difficult respiration, etc.

In general, dolphins are very powerful and graceful animals in an aquatic environment but become very helpless on land. The dolphin uses its caudal fins to try to alter its very uncomfortable situation and escape back into the water. They very seldom succeed.

The Black Sea dolphins are predators and have no equals in power or swimming speed. Based on our observations, dolphins are harmless animals for most of the Black Sea species of fish. However, dolphins are destroying our very valuable resources of commercial fish and might be considered as competitors with humans for the the same fish. On the other hand, the dolphin is a very important member of the human food chain and is the main source of precious fat.

COMMERCIAL CATCH OF DOLPHINS

Marine fat, i.e., fatty substances obtained from marine fish and marine mammals (whales, seals, walruses and dolphins), has attracted human attention from ancient times. The commercial catch of whales began in the XII century in the Bay of Biscayne. Hunting for walruses and whales is known to have been carried out by northern tribes (Eskimo, Chukchi) as a way to survive in a very unfriendly environment. Until recent times, marine mammals such as large whales and walruses were the only source of fat. As a result, some species of large whales have been forced to the brink of extinction and others need

serious protective measures to ensure their survival.

Dolphin fat is not very important in the total world production of marine fatty substances. Total production of dolphin fat does not exceed 2500 tons. This might be explained by the fact that the amount of fat collected from one dolphin is relatively insignificant compared to that for a large whale. The total commercial catch of Black Sea dolphins in the past was never significantly important to the industrial or economic life of the nation. The commercial catch was either accidental or conducted by a few individuals.

Recently, when the Government took control of the commercial catch of dolphins on the Black Sea, and especially in the Crimean region, commercial hunting became more effective, utilization of dead dolphins became more complete and a more satisfactory type of net (aleman) was introduced. The main product of the commercial catch of dolphins is fat; it serves as a raw product for production of technical oil and a very nutritional medical fat, "del'finol." This product is very rich in vitamins. The amount of anti-rickets vitamin D in "del'finol" is 4 times higher than in regular medical oil obtained from codfish liver. Dolphin skin, after special treatment, produces a high quality leather. Dolphin bones are used as a very efficient fertilizer, and the meat for manufacturing various sausages and canned meat.

The most common method of killing dolphins is by using high caliber shotguns with large pellets. The hunter stands in the bow of the boat and shoots every time a dolphin surfaces to breathe. The dead or wounded animal is picked up with a boat hook and delivered to the dock. Each boat kills between 50 and 100 dolphins during 1-2 days of hunting. Dead carcasses are delivered to the factory where they undergo the process of separation of components (fat, meat, bones, etc.). The commercial catch of dolphins by shooting is very small. Hunters usually lose a lot of wounded animals that, as a rule, will die later. During the summer, a dolphin carcass sinks very fast, and if a diver is not able to save it, the body disappears quickly into the water. On the average, during this type of commercial killing and especially during the summer season, up to 50% of the animals are lost. Also, the summer catch, due to minimum amount of body fat at this time, is less valuable than the winter catch.

Another method used since 1929 in the commercial catch of dolphins, especially in southern parts of the Crimea, is the utilization of a special large net, called an aleman. The length of this net is between 600 and 1000 meters and the depth is 100 meters. Hundreds and even thousands of dolphins may be caught simultaneously in this type of net. The net is a more progressive method of hunting compared to a shotgun. The great number of animals which may be caught at the same time made this method very cost efficient. The behavior of dolphins after being surrounded by a net varies drastically. The common dolphin begins to swim helplessly on the surface. The bottlenose dolphin, on the contrary, very often manages to find its way out of the net; it simply dives under the lower edges of the net to freedom. Apparently, the species vary in their ability to dive into the depths.

The commercial capture of dolphins depends totally on sea conditions. Stormy weather makes it practically impossible. Thus, the most favorable time for a commercial hunt is during migration of the fish schools and in clear and quiet weather. The most successful summer months for hunting are May, June

and August. In July, the common dolphin, which usually lives in near-shore waters, goes far off-shore. The common porpoise's hunting season becomes very successful in October and November, when the anchovy start to migrate. The bottlenose dolphin is never abundant in catches. Each boat has a crew of 4-5 people, and they catch on the average 800-900 dolphins a year. This produces about 20,000 kg of fat. The following are statistics on the commercial hunting of dolphins in the Black Sea area. In the Sebastopol-Yalta region, during the 8 months from January 1 to August 1, 1931, 78 boats using 5 nets (aleman) killed 18,121 dolphins, so potentially 180,000 kg of fat were collected. Add to these impressive figures the amount of leather, meat, fertilizer, etc., and the economical significance of the dolphin hunt becomes very obvious. Since these statistical data are from only one organization (Azcherrybtrest), we believe that the total production may be up to 30-40% if we include the other cooperative in Sebastopol. The Yalta region will begin commercial catching of dolphins in the relatively near future. In the Azov-Black Sea region, the following are data pertaining to production of medical fat (del'finol) obtained mainly from common dolphins.

1929	50,000 kg
1930	110,000 kg

Further, based on a five-year plan, the following numbers are projected:

1931	240,000 kg
1932	460,000 kg
1933	700,000 kg

Without doubt, further development of commercial catch of dolphins will be a very important economic consideration for our nation. But, if we ask the question "How soon will we deplete the population of Black Sea dolphins?", the answer is absolutely clear: very soon. The dolphins' future may be similar to that of the Greenland whales, which were driven to extinction by commercial hunting. The Black Sea dolphin population is large but not endless. The reproduction of these species is not fast enough to replace the catch. We should develop a conservation program and strict quotas for commercial hunting. The entire catch should be conducted by means of fishing nets (alemans). Killing of young animals should be completely stopped. In certain periods of the year, we should stop the killing of females as well. We have to study different biological aspects of dolphin life in order to carry out intelligent hunting. We have to proceed with population censuses for all three species of Black Sea dolphins.

Academy of Sciences of U.S.S.R.
Institute of Oceanology

S.K. Klumov

ON THE REPRODUCTIVE CYCLE OF THE
BLACK SEA COMMON DOLPHIN-BELOBOCHKA*
1954

The reproductive cycle of the Black Sea common dolphin (*Delphinus delphis ponticus* Barabash) was studied in recent years by Malm & Trotskaya, 1936; Kleinenberg, 1939; and Sleptsov, 1940, 1941. These researchers established the main elements of reproductive biology of the species. Their data showed that the middle of summer (July) is the peak of calving season and that by the end of August calving has practically ceased. Some individuals give birth all year round, but these events are extremely rare.

Mating season begins at the end of June and is practically over by October. Here, as well, we encountered some exceptions.

Gestation period is 10-11 months. The length of the lactation period is not definitely known but is presumably 4-6 months. Female dolphins give birth to only one calf. Twins are very rare. Most females reach puberty at the age of 3 years. However, some females become mature at the age of 2 and may participate in reproduction at this time. Males, as a rule, reach maturity much later - at 4 years of age. During one life span, females probably give birth to 8 to 12 calves. Part of the evidence for this conclusion is the number of corpora albicantia in female ovaries. The life span of the common dolphin is probably 18 to 20 years.

Presented data on the reproductive biology of the Black Sea common dolphin are consistent between authors, and we do not have any arguments on this matter. However, one aspect of reproductive activity still is not very clear. It is related to the periodicity of reproduction. Malm & Trotskaya (1936) believed that dolphins give birth to young two out of three years, i.e., every 18-20 months. Mayorova & Danilevskiy (1934), on the contrary, argued that a birth occurs once every three years. Sleptsov (1940, 1941) indicated that the timing of birth by an individual female shifts every year by one to two months, and as a result the lactation period is also shifted. Once every three years, mature females miss the mating season and are barren in this particular year. If this cycle is followed, periodicity of mass calving may be presented in the following scheme: calving occurs three years in a row, with a one-to two-month delay compared to that of the previous year, and every fourth year the female is left out of the reproduction season and is barren.

*Data presented in this contribution were obtained from the Laboratory of Marine Mammals of the All-Union Institute of Fishery and Oceanography.

The method of determining mass calving periodicity varies with different researchers. Mayorova and Danilevskiy (1934) based their analysis on composition of the catch of females, in terms of a percentage pregnant, lactating, and barren in different months of the year. We want to point out that these authors made a serious mistake in their speculations in defining the period of mass calving. They wrote:

"If we assume that January is the middle of the reproductive cycle, then every year one-half of the mature females will be barren, one-fourth lactating (gave birth in the previous year) and one-fourth pregnant (giving birth in the present year). Therefore, females give birth to a calf once every three years or the following fourth year."

However, we completely disagree with this conclusion. Indeed, if these authors are correct, then in the first summer females are involved in mating, in the second summer in parturition, and the third summer is the end of the lactation period (weaning of young) and the female is barren. In the fourth year, mating occurs again. If this periodicity is correct, then this cycle would be repeated every three years, i.e., calving would occur every third year. It is not clear what would cause such a prolonged barren period, since we know that even lactating females may mate normally.

M. Sleptsov (1940) based his conclusions on two basic conditions: 1) post-parturitional changes in the reproductive tract of females disappear within two months, and 2) at the end of this period the female is ready to mate again. In the fall, a great number of females had both milk in their mammary glands and a fetus in their uterus or a corpus luteum in their ovaries. Sometimes we were able to determine pregnancy only because of the presence of the corpus luteum, since the fetus was so small that we failed to detect it in the uterus! Sleptsov's method is not very progressive and has two very serious errors. First, females may participate in mating before post-parturitional changes have occurred. This phenomenon is very common in horses, cows, sheep, pigs, rats, rabbits, and other animals, including sea otters. We may assume with a great degree of probability that the same situation is common for dolphins as well. Shifting of calving time is highly improbable. The second statement given by M. Sleptsov does not support the data on correlation between lactating and pregnant females. It also does not support data presented on mature females between barren and lactation times, but not pregnant. Malm & Trotskaya (1936), in arguing with the data of Mayorova & Danilevskiy (1934), do not support their findings with any hard evidence. For this reason we will evaluate their statement that "females give birth to a calf twice every three years." We studied catch composition of Black Sea common dolphin females from March to August of 1934 for the Yalta¹ region and June-September (six catches) in 1939 in the Tuapse² region.

The total number of mature females studied was 3320 in 1934 and 259 in 1939. Results are given in Tables 2-8. The analysis made in 1939 was

¹Data collected by I.F. Tryuber

²Data collected by S.E. Kleinenberg

substantially different from that done in 1934. In 1934 the main emphasis was on the following parameters: body length, presence of milk in mammary glands, and presence of fetus. Females which had neither milk nor a fetus were classified as barren. Ovaries were not studied. In 1939, for the first time, a very extensive study was done of ovaries. We made a large collection of ovaries in the field and then studied them in the laboratory. At first we decided to conduct our study in a manner similar to that of Mayorova & Danilevskiy. Consequently, our results on the ratios between pregnant, lactating and barren females were close to those of these two researchers. Mayorova & Danilevskiy took a body length of 150 cm as a criterion for sexual maturity in common dolphin females. Further studies by G.E. Nikol'skiy, I.F. Tryuber & S.E. Kleinenberg showed that the minimum body length of sexually mature females is 156 cm. We agree with this figure and use it in our study.

1934 data showing the proportion of pregnant, lactating and barren females on a monthly basis are presented in Table I. Considering the data in Table I, we may note that for the first three months (March, April, May) our data are apparently insufficient, since a diminishing number of pregnant females in April (up to 5%) and subsequent increase of their number in May (up to 10%) is very difficult to explain. The same situation occurs with an increase in the numbers of barren females (from 58% to 67%). We presume that this inconsistency is a result of insufficient data. In spite of this fact, the total number of pregnant and lactating females in this month is equal to 40% and more.

Beginning in June, our material is sufficient and we may present a true picture on distribution of different groups of females during the summer months (June-August). A gradual decrease in the number of pregnant females and increase in the number of lactating females indicates that this is a very intensive calving season. At the end of August, calving has practically ceased; the number of pregnant females with large fetuses at this time is negligible: 16% in 1934 and 2.4% in 1931 (Mayorova & Danilevskiy data). Table I shows that in August the percentage of barren females has drastically increased, and at the same time the percentage of lactating females has dropped, although in theory the last number should also increase. Neither of these figures correctly represent the real situation.

Determination of pregnancy in the early stages is rather difficult, and analysis of ovaries should be made by very experienced observers. In 1934, as we mentioned, we studied just the uterus and did not pay any attention to the ovaries. For this reason a number of females in the early stages of pregnancy were referred to as barren. The decrease in the numbers of lactating females may be explained as follows: out of 1032 specimens of females collected in August of 1934, only a small percentage were studied for the presence of milk; as a result, the majority of them were classified as barren. Thus, our material for August is not very reliable. In reality, the number of barren females should be significantly lower because of the increase in lactating females and the increase in the number of newly fertilized females and females in the early stages of pregnancy. Based on the data from Table I, we present the following proportions of pregnant, lactating, and barren females from March through July (excluding August):

barren	-	1225 specimens (53.5%)
pregnant	-	331 specimens (14.6%)

lactating - 732 specimens (31.9%).

Thus, more than 50% of all sexually mature females remain barren every year, 30% of females are lactating and the rest of them (15%) are pregnant. Therefore we may conclude that females do not give birth to a calf every year, since the obtained data showed that calving occurs every two years (or three). This calculation would be correct if we assume that the lactation period lasts more than a year. However, we have not been able to determine this in the field. The most recent experimental data related to this problem were found in McBride's study (1940) based on behavioral observations of captive dolphins in a Florida oceanarium. In March of 1938, a female with a calf was captured. The female fed the calf every 15-30 minutes. The length of each nursing period was not more than 5 seconds, since the calf was only able to stay underwater a maximum of 30 seconds. The nursing process was as follows: the calf usually approached the female from below and touched the region of the mammary glands with its rostrum, slightly opening its mouth. The female probably contracted its circular muscles located around the mammary glands and squirted a strong jet of milk into the calf's mouth.

After three weeks in captivity, the young dolphin began to make attempts to eat solid food (fish). On the fourth week, he swallowed a fish, after which he became sick and switched back to nursing. He started to eat fish steadily in the 11th week of captivity. For the next three weeks, he consumed both milk and solid fish; and finally, after 14 weeks in captivity, he completely switched to solid food. When the calf was collected in March, he was probably 1.5-2 months old. Based on this reasoning, we assume that the lactating period of dolphins does not exceed 6 months and is probably shorter than that.

In April of 1934, 10 dolphin herds were collected. Out of this large number of animals, only 151 sexually mature females were obtained, seven of which were pregnant and 43 lactating (Table 3).

In May, we observed the same situation. Out of 200 sexually mature females, 21 (about 10%) were pregnant. A total of 21 herds of animals were collected (Table 4).

Out of 31 herds collected in June, only 209 of the total number of 894 sexually mature females were pregnant. One hundred fifty-six pregnant females came from 5 herds (Table 5). The same situation occurred in July (Table 6), when 5 herds gave us 58 pregnant females out of 70 collected that month. In August, just 16 pregnant females were taken from 25 herds; one herd had 7 pregnant females and another just 4; the rest had a maximum of 1-2 (Table 7).

In considering the composition of the herds containing pregnant females, we noticed that all herds, without exception, consisted primarily of females, and that most of the males were sexually immature. On the other hand, in herds where pregnant females were absent, sexually mature males prevailed. Therefore, we came to a conclusion similar to that of Kleinenberg (1939), Sleptsov (1940; 1941), and Tsalkin (1940), i.e., that herds of pregnant females, especially during last stages of pregnancy, are separated from sexually mature males and barren females. They leave inshore waters and migrate offshore. Barren females and sexually mature males travel significantly faster in open water regions, and therefore make up the major

part of dolphin catches in this period.

Separation of pregnant females from the rest of the animals has the following significance: Pregnant females, during the last stages of pregnancy, can not travel as fast as strong mature males or barren females. They are searching for quiet areas where they can give birth. We seriously doubt that the open sea might be considered a quiet area compared to inshore waters.

There is another consideration which might change our conclusion. As we mentioned before, we call sexually mature those females whose body length reaches 156 cm. Analysis of data for 1939 (Table 8) collected by Kleinenberg represented the following picture: out of 259 females estimated to be sexually mature, based on a body-length criterion, 80 turned out to be sexually immature, even though their body lengths were 160 cm and even 170 cm. Both large follicles and corpora lutea were absent in the ovaries of these females, even though the animals were captured at the height of the mating season. Eighty-five females were barren, the rest were either lactating or pregnant, or lactating and carrying fetuses in the early states of development.

Thus, sexual maturity in female dolphins can not be strictly correlated with body length as was previously thought. Female body length is not a simple function of age and sexual maturity. During our study we came across pregnant and lactating females with body lengths of 145-148-150 cm, and, on the other hand, a great number of females with body lengths of 160-165 cm and 170 cm turned out to be sexually immature.

Therefore, the accepted criterion for estimating sexual maturity - body length of females equal to 156 cm - is not correct. In our opinion, the only criterion for determining sexual maturity in females is the condition of the ovaries. The presence of corpora lutea and corpora albicantia classifies females as potentially reproductive.

Now, looking back at Table 1, and considering our new concepts based on data obtained in the 1939 catches, we may state that the number of barren females, which originally totalled 53%, should be less or even half of this number. Since they were sexually immature they cannot be considered a reproducing part of the herd. Based on this, a new breakdown of females pregnant, lactating or barren would be absolutely different.

The first and most important condition for collected morphological material is that it should be of sufficient amount for statistical analysis. The test sample should be rather large and represent accurately the sex and age groups in the herd. We know definitely by now that during the spring and summer period (April-September), dolphin herds group according to sex and age. Another definite finding is that pregnant females stay separated from other sexually mature or barren females, or sexually mature males, at least during the last part of their pregnancy. Apparently, they remained separated immediately after calving, because the youngsters are not yet capable of swimming fast. Thus, the best time to collect morphological material would be the period when males and females (both mature and immature) are staying together. Apparently, the period of early pregnancy (late fall and early winter months) when the pregnant females are not heavy yet, but the youngsters

are big enough to follow the adults without any complications, would be the best time for collecting data. Nevertheless, we cannot be absolutely positive in stating that in late fall and early winter dolphin herds are completely mixed and that any large sample would accurately represent the sex and age structures. There is no commercial catching of dolphins during these seasons and therefore no data. The second most important condition is the thorough examination of the reproductive tract of each female. Primary consideration should be given to the condition of the gonads. It would be even better to study the reproductive system both in the field and in the laboratory. The following conditions are of paramount importance when studying the reproductive system of female dolphins.

1. Ovulation, mating and pregnancy begin for lactating females without full involution of the uterus.

2. Lactation ceases immediately if there is a disappearance of the corresponding neural impulse and resumption of hormonal activity (usually a couple of days after the calf is weaned).

3. Lactation of females in the last stages of pregnancy is a very good indication of the pre-parturition condition, and its beginning is stimulated by the separation of the placenta from the uterine wall. Lactation in these females may be determined only when development of the fetus has reached the final stages. Milk secretion in pregnant females might be seen, however, after a fetus dies.

4. The absence of milk (in barren females) may be a result of the fact that a female is not ready for mating during the mating season and consequently drops out of the reproductive cycle of the population.

In summarizing the above information, we might state that in order to solve problems regarding periodicity in the calving of the Black Sea dolphin, the following data are necessary:

- a. A rather large sample representing accurately the sex and age structure of groups of dolphins during October-February (at this time it is rather easy to determine the condition of the reproductive organs).

- b. Field analysis of the reproductive tracts of females, mainly ovaries (presence of corpora albicantia and corpora lutea), uterus (presence of fetuses) and mammary glands (presence of milk), as well as results of laboratory studies on ovaries.

- c. The ratio between sexually mature and immature females (based on analysis of ovaries); and for mature females, the relative number of pregnant, lactating and barren individuals.

In order to facilitate studies, let us consider the possible variation in ratio of pregnant, lactating and barren females which might be obtained using different periodicity in calving. As a basis for our speculations, we will consider the already-known data on the reproductive biology of dolphins. Biological features are: the peak of the calving season is July, gestation period is 10-11 months, length of the lactation period is 4-6 months, etc. There are fluctuations in these variables, but we shall ignore them, since

they are very hard to calculate. Let us consider several different possibilities.

Calving every year - In spring (March, April, May), almost 100% of the reproductively mature females are pregnant. There is a small portion of females which are already lactating (early calving). In summer (June, July, August), the majority of females are lactating; some females have large, near-term fetuses, and there is a small proportion of just-ovulated females in the early states of pregnancy. Barren females are scarce.

In winter (November, December, January, February), all females are pregnant.

Calving every other year - In spring almost 50% of the sexually mature females are pregnant, excluding females who gave birth and therefore are still lactating at this time. The remaining 50% are barren, if lactation does not last more than 6 months. In summer, about 50% are lactating and 50% mate. Some females of the second group are in the early states of pregnancy. A small proportion of females, those who missed the mating season, are barren.

In the winter months, 50% of the females are pregnant, the other 50% are lactating. At the end of the winter period, most of the females have their "off-spring" and therefore become barren.

Calving every 2 or 3 years - This situation is possible only if lactation lasts 13-14 months and if lactating females do not participate in mating in the year immediately after calving. Under these circumstances, we will have the following situation during spring months: 33% of females are pregnant, 33% lactating, and 33% are barren. In the fall and winter seasons, the same ratio should exist for mature females. In the summer months (June, July, August), and even in September, the ratios between pregnant, lactating and barren females can not even be approximated because of the very intensive mating season; different ratios are possible in different groups of females. Because of this, definite conclusions can not be reached.

Calving every two years; rest on the 3rd year - This situation is possible under the following circumstances:

a. Mating may occur only after complete involution of the uterus and leveling off of all post-parturition changes;

b. Lactation does not exclude possible ovulation, mating and involvement in a new pregnancy;

c. Leveling off of all post-parturition changes at 1.5-2 months after the yearly calving period; in the 3rd year some females would drop from the population's reproductive cycle and remain barren.

Under these circumstances, we would have the following alteration in the number of pregnant, lactating and barren females. In spring: 66% pregnant and 33% barren; in fall-winter months: 66% pregnant (about 50% of this number still in lactation) and 33% females without fetuses.

Three years calving (every year), and 4th year rest - A 4-year cycle in calving periodicity is possible if the aforementioned conditions continue without any change. The ratios between pregnant, lactating and barren females are changed as follows: in spring, 75% pregnant and 25% barren females; in late fall and early winter months, 75% pregnant (about 2/3 are still nursing their young and are therefore to be considered as pregnant and lactating at the same time); and 25% of lactating females without fetuses (they will be barren in a few months). In summer months, when calving and mating take place, the ratio between pregnant, lactating and barren females would be hard to determine. At this time any combination is possible. However, the total number of barren females is less than 25%. Based on the material presented, we presume that the most convenient times for collecting data for determining calving periodicity are the late fall and early winter months, such as October and February. We did not consider here the possibilities of calving once every three, four, etc., years, because we believe that such a reproductive cycle in whales, and in dolphins in particular, can not exist. For the same reason, we omit other hypothetical cases such as: 4 years calving and 5th year rest, 5 years calving and rest in 6th year, etc.

Based on our analysis, we believe that calving among the main mass of sexually mature females of the Black Sea dolphin occurs on a yearly basis. Although we constantly observed an insignificant number of barren females, we believe that this phenomenon is more an exception than a rule. Most cases are apparently connected with the individual peculiarities of females during the mating season (beginning of estrus period after the mating season is over, especially in young females; prolonged gestation period and late parturition, etc.). However, all our conclusions cannot be supported by solid factual material; therefore, the problem of calving periodicity among females of the Black Sea dolphin should be further studied as recommended in this paper.

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Table 1. Ratios between barren, pregnant and lactating females in Black Sea dolphin catches during 1931 and 1934.

Month	Number of studied females (n)		% barren		% pregnant		% lactating	
	Mayorova data (1931)	Our data (1934)	Mayorova data (1931)	Our data (1934)	Mayorova data (1931)	Our data (1934)	Mayorova data (1931)	Our data (1934)
March	201	145	67.6	58.6	22	16.5	10.4	24.9
April	194	151	63.4	66.8	19.6	4.8	17.0	28.4
May	66	200	54.9	56.0	18.3	10.5	27.2	33.5
June	-	894	-	50.1	-	23.4	-	26.5
July	119	898	63.9	53.0	10.8	11.5	25.2	35.5
August	167	1032	59.9	70.2	2.4	1.6*	37.7	28.2
September	49	-	34.4	-	-	-	65.6	-

*All pregnant females had well developed fetuses.

Table 2. Catch composition of Black Sea dolphins in Yalta region (March 1934)
(Data by I.F. Tryuber).

Catch number	Date	Total number studied	♂	♀	Number of females				
					Immature	Mature	Barren	Pregnant	Lactating
1	18	63	39	24	6	18	11	3	4
2	19	205	84	121	32	89	54	17	18
3	19	14	6	8	2	6	4	1	1
4	19	23	21	2	1	1	1	-	-
5	22	70	22	48	17	31	15	3	13
Total		375	172	203	58	145	145	85	36

Table 3. Catch composition of Black Sea dolphins in Yalta region (April 1934)
(Data by I.F. Tryuber)

Catch number	Date	Total number studied	♂	♀	Number of females				
					Immature	Mature	Barren	Pregnant	Lactating
1	9	45	41	4	-	4	3	-	1
2	5	19	9	10	4	6	5	-	1
3	16	121	115	6	2	4	4	-	-
4	16	20	10	10	3	7	5	-	2
5	18	163	68	95	29	66	40	6	20
6	19	41	13	28	13	15	9	-	6
7	20	56	31	25	11	14	10	-	4
8	21	12	3	9	3	6	1	-	5
9	22	20	7	13	4	9	5	-	4
10	23	256	219	37	17	20	19	1	-
Total		753	516	237	86	151	101	7	43

Table 4. Catch composition of Black Sea dolphins in Yalta region (May 1934)
(Data by I.F. Tryuber)

Catch number	Date	Total number studied	♂	♀	Number of females				
					Immature	Mature	Barren	Pregnant	Lactating
1	1	17	13	4	-	4	-	3	1
2	1	48	13	35	8	27	11	9	7
3	2	38	29	9	5	4	2	-	2
4	3	26	18	8	6	2	-	-	2
5	3	12	6	6	2	4	2	1	1
6	17	46	30	16	6	10	10	-	-
7	18	20	12	8	1	7	4	-	3
8	18	40	28	12	6	6	4	-	2
9	19	30	19	11	1	10	9	1	-
10	19	37	21	16	4	12	6	1	5
11	20	56	27	29	6	23	14	2	7
12	25	14	8	6	5	1	-	-	1
13	27	104	91	13	9	4	4	-	-
14	28	118	75	43	28	15	10	1	4
15	28	39	25	14	4	10	7	1	2
16	28	73	40	33	22	11	9	-	2
17	30	38	13	25	7	18	8	-	10
18	30	28	16	12	3	9	2	2	5
19	31	11	5	6	3	3	1	-	2
20	31	26	11	15	7	8	1	-	7
21	31	40	18	22	10	12	8	-	4
Total		861	518	343	143	200	112	21	67

Table 5. Catch composition of Black Sea dolphin in Yalta region (June 1934)
(Data by I.F. Tryuber)

Catch number	Date	Total number studied	Number of females						
			♂	♀	Immature	Mature	Barren	Pregnant	Lactating
1	10	171	99	72	33	39	21	5	13
2	10	40	22	18	2	16	9	-	7
3	10	71	40	31	16	15	14	-	1
4	11	53	30	23	10	13	4	-	9
5	14	75	45	30	16	14	3	3	1
6	14	95	65	30	12	18	14	3	1
7	15	96	36	60	21	39	11	13	15
8	16	53	22	31	5	26	20	5	1
9	19	29	15	14	3	11	8	-	3
10	19	216	135	81	32	49	34	-	15
11	19	105	51	54	16	38	31	2	5
12	19	49	24	25	16	10	6	47	4
13	20	136	60	76	20	56	9	7	-
14	20	158	93	65	21	44	31	-	6
15	20	172	116	56	30	26	21	-	5
16	20	95	63	32	17	15	7	2	8
17	21	34	22	12	3	9	5	-	2
18	22	73	32	41	18	23	3	-	20
19	22	136	69	67	34	33	16	-	17
20	24	48	28	20	9	11	7	57	4
21	24	193	83	110	26	84	17	1	10
22	24	121	69	52	30	22	19	7	2
23	26	46	25	21	7	14	6	22	1
24	26	66	24	42	11	31	9	-	-
25	26	131	101	30	19	11	9	5	2
26	27	90	37	53	14	28	11	1	12
27	28	96	70	26	14	12	10	17	1
28	28	237	104	133	43	90	39	5	34
29	28	71	30	41	10	31	15	6	11
30	28	70	33	37	12	26	15	1	5
31	29	119	50	69	29	40	17	-	22
Total		3135	1693	1442	548	894	448	209	237

Table 6. Catch composition of Black Sea dolphins in Yalta region (July 1934)
(Data by I.F. Tryuber)

Catch number	Date	Total number studied	♂	♀	Number of females				
					Immature	Mature	Barren	Pregnant	Lactating
1	1	161	89	72	32	40	25	2	14
2	7	112	68	44	14	30	14	12	4
3	7	43	21	22	9	11	5	-	8
4	8	289	134	155	58	97	42	10	45
5	8	329	183	146	77	69	49	-	20
6	8	298	141	157	62	95	50	11	34
7	8	160	102	58	25	33	22	-	11
8	9	200	96	104	50	54	23	-	31
9	9	124	55	69	24	45	29	-	16
10	9	98	60	38	23	15	7	1	7
11	9	263	136	127	42	85	36	12	37
12	14	66	40	26	12	14	13	-	1
13	14	56	37	19	7	12	10	-	2
14	14	105	69	36	15	21	20	1	-
15	15	68	48	23	16	7	5	-	2
16	16	308	170	138	39	99	25	3	71
17	17	96	45	51	17	34	13	5	16
18	30	29	13	16	3	13	7	-	6
19	30	50	19	31	13	18	15	1	2
20	30	168	72	96	22	74	51	13	10
21	31	66	33	33	8	25	15	-	10
22	31	17	11	6	1	5	3	-	2
Total		3106	1639	1467	569	898	479	70	349

Table 7. Catch composition of Black Sea dolphins in Yalta region (August 1934) (Data by I.F. Tryuber)

Catch number	Date	Total number studied	♂	♀	Number of females				
					Immature	Mature	Barren	Pregnant	Lactating
1	4	75	39	36	6	30	16	-	14
2	4	130	52	78	36	42	19	-	23
3	5	47	30	17	4	13	6	-	7
4	5	149	35	114	45	69	38	-	31
5	5	159	83	76	39	37	33	-	4
6	6	177	83	94	33	61	45	-	16
7	6	24	13	11	6	5	5	-	-
8	9	50	39	11	7	4	4	-	-
9	10	94	41	53	13	40	20	7	13
10	14	112	60	52	14	38	20	-	18
11	14	27	12	15	1	14	10	2	2
12	14	81	34	47	8	39	30	-	9
13	16	85	32	53	15	38	15	-	23
14	16	167	59	108	12	96	72	1	23
15	16	127	44	83	7	76	61	4	11
16	22	55	31	24	2	22	17	-	5
17	22*	106	59	47	19	28	21	-	7
18	23	132	70	62	13	49	37	-	12
19	23	193	106	87	27	60	52	1	7
20	23	112	64	48	7	41	36	-	5
21	24**	320	208	112	36	76	37	1	18
22	24***	470	276	194	60	134	95	-	39
23	30	57	27	30	15	15	13	-	2
24	31	15	13	2	1	1	1	-	-
25	31	23	16	7	3	4	2	-	2
Total		3017	1546	1471	439	1032	725	16	291

* Two catches

** Two catches 147 and 173

***Two catches 300 and 170

Table 8. Correlation between females in catches at the Black Sea dolphins in Tuapse region (1939) (Data by S.E. Kleinenberg)

Catch number	Date	Total number studied	Number of females					
			Immature	Infants (calves)	Mature	Barren	Pregnant	Lactating
1	2.VI	76	36	19	21	14	1	6
2	3.VI	198	99	35	64	23	19	22*
3	7.VI	47	35	9	3	1	-	2
4	5.VIII	39	24	-	15	3	9	3**
5	18.VIII	71	38	3	30	4	25	1***
6	11.IX	249	109	14	126	40	12	75****
Total			341	80	259	85	66	108*****

* 3 ♀'s had both milk and corpus luteum

** 3 ♀'s had both milk and corpus luteum

*** This female had both milk and corpus luteum

**** 4 ♀'s had both milk and corpus luteum

*****10 ♀'s out of this number had both milk and corpus luteum. Assuming that 100% of ♀'s were mature we have the following ratios:

Barren - 32.8%
Lactating - 41.7%
Pregnant - 25.5%

During August-September

Barren - 47 or 27.5%
Lactating - 71 or 41.5%
Pregnant - 53 or 31.0%

Total - 171 or 100%

